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SAFETY AND HEALTH STANDARDS AND REGULATIONS FOR CONSTRUCTION

Ground-Fault Protection

Title 29—Labor

CHAPTER XVII—OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION, DEPARTMENT OF LABOR

[Docket No. S–102]

PART 1910—OCCUPATIONAL SAFETY AND HEALTH STANDARDS

PART 1926—SAFETY AND HEALTH REGULATIONS FOR CONSTRUCTION

Ground-Fault Protection

Pursuant to sections 6(b) and 8(c) of the Williams-Steiger Occupational Safety and Health Act of 1970 (84 Stat. 1593, 1599; 29 U.S.C. 655, 657) (the Act), section 107 of the Contract Work Hours and Safety Standards Act (Construction Safety Act) (83 Stat. 96, 40 U.S.C. 333), Secretary of Labor's Order No. 8–76 (41 FR 25059), and 29 CFR Part 1911, Parts 1910 and 1926 of Title 29, Code of Federal Regulations, are hereby amended by revising §§ 1910.309(c) and 1926.400(h) to require either the use of ground-fault circuit interrupters or the implementation of an assured equipment grounding conductor program on construction sites.

I. BACKGROUND

Each year many workers on construction sites suffer electric shock using portable electric tools and equipment. The nature of the injuries, including those caused by ground faults, ranges from electrocutions to minor and serious secondary injuries. A secondary injury occurs when a worker recoils from an electric shock and, as a result of this recoil, sustains an injury. Depending largely on the surrounding physical conditions, such an accident can result in a bruise or a broken bone or a fatal fall. An electrocution occurs when the shock current is in excess of about 70 milliamperes causing ventricular fibrillation and death. Typically, these injuries occur when employees contact electrically energized parts. It is usually the frame of the tool that becomes accidentally energized due to an electrical fault which provides a conductive path to the tool casing. This conductive path can occur instantaneously or can develop gradually over a relatively long period of time. When the worker contacts the energized tool, a fault to ground may occur. This means an unwanted path or circuit of electricity develops from the tool through the man to ground. The amount of current that flows through the worker depends, primarily, upon the resistance of the fault within the tool, the resistance of the worker, and the resistance of the path from the worker back to the electrical supply.

Moisture in the atmosphere may contribute to the electrical fault by intensifying both the conductive path within the tool and the external path back to the electrical supply. Moisture may also increase the severity of the shock by decreasing the worker's contact resistance. Consequently, the extent of the hazard increases with an increase in the amount of moisture at the jobsite.

One method of protection against injury caused by this electrical fault is the use of an equipment grounding conductor. This equipment grounding conductor grounds the exposed noncurrent-carrying, metal parts of tools or equipment and carries off the leakage current thus limiting the voltage on the tool frame by providing a low resistance path to ground. When the leakage current increases beyond the setting of the overcurrent device protecting the circuit (usually 15 or 20 amperes), the device trips and interrupts the current.

Another method of protection is the utilization of a ground-fault circuit interrupter (GFCI). This device continually monitors the current and detects current leaking to ground via a path outside of the circuit conductors. If the leakage current to ground (either through the equipment grounding conductor or through a person) exceeds the trip level, the circuit is interrupted quickly enough to prevent electrocution.

II. HISTORY OF THE REGULATIONS

In accordance with section 6(a) of the Act, the Occupational Safety and Health Administration (OSHA) adopted by reference in §§ 1910.309 and 1926.400 of its general industry and construction regulations the 1971 National Electrical Code, NFPA 70–1971, ANSI C1–1971 (NEC), 37 FR 3431 (1972). In addition to requiring proper grounding of electrical tools, the NEC contains, in section 210–7, the following provision:

> All 15- and 20-ampere receptacle outlets on single-phase circuits for construction sites shall have approved ground-fault circuit protection for personnel. This requirement shall become effective on January 1, 1974.

On November 8, 1973, the Advisory Committee on Construction Safety and Health, established under the Construction Safety Act, recommended to the Assistant Secretary of Labor for Occupational Safety and Health that the effective date of the GFCI requirement be suspended pending further study. A request for postponement was also made by the National Constructors Association on November 19, 1973. Accordingly, on December 4, 1973, a notice was published in the FEDERAL REGISTER (38 FR 33397) amending §§ 1910.309 and 1926.400, to defer the January 1, 1974 effective date pending reconsideration of the requirement for GFCI's.

In order to obtain the information necessary for such reconsideration, a notice of public hearing was published in the FEDERAL REGISTER on December 10, 1973 (38 FR 33983), and the issues subject to comment were listed on December 26, 1973 (38 FR 35235). A public hearing was held on February 26, 1974.

An issue on the scope of the requirement was raised in several comments and in the course of the hearing. Specifically, the issue was whether the GFCI requirement should be expanded from temporary wiring on construction sites to include any workplace that was "wet, damp, or conductive" and where electrical tools were used. In response to this, OSHA published an Advance Notice of Proposed Rulemaking on June 11, 1974, (39 FR 20499) requesting information regarding this expansion of scope.

After evaluating all the comments and evidence received in response to the various FEDERAL REGISTER notices, OSHA concluded that a requirement for GFCI's on any wet, damp, or conductive location, rather than only on construction sites, was not necessary. This conclusion was based on the permanent nature of the electrical installations and the condition and maintenance of electrical tools and equipment used in general industry, as contrasted with the temporary wiring, which is frequently moved, and the rough use, abuse, and the relatively poorer condition and maintenance of electrical tools and equipment found on construction sites. Accordingly, OSHA prepared and submitted a draft of a proposed ground-fault circuit protection standard to the Advisory Committee on Construction Safety and Health at its October 30, 1974 meeting. This draft standard would have required ground-fault circuit interrupters for all 120-volt receptacle outlets on the temporary wiring of construction sites, which were used by employees. The Advisory Committee recommended to continue to hold the ground-fault circuit protection standard in abeyance, pending independent study of the need and efficacy of GFCI's.

On April 7, 1975, a notice of proposed rulemaking was published in the FEDERAL REGISTER (40 FR 15390; correction notice, 40 FR 18468). In this notice, OSHA proposed to amend Title 29, Code of Federal Regulations, §§ 1910.309(c) and 1926.400(h) by revoking the requirements for GFCI's on construction sites, on the view that sufficient data had not been received showing such a requirement to be necessary to the safety and health of employees. The proposal notice indicated that the revocation could be changed if there were a later determination that complete and accurate information was available which warranted mandatory utilization of GFCI's on construction sites.

In response to this notice, OSHA received 131 comments, including six requests for a public hearing. Thereupon, a notice of public hearing was published on September 2, 1975 (40 FR 40170). In this notice, OSHA requested public comment on numerous issues which would enable OSHA to determine which of the following actions to take for protection of personnel on construction sites: (a) revocation of the existing requirement for GFCI's; (b) retention of the existing requirement for GFCI's; or (c) a requirement for GFCI's or an alternate grounding maintenance program, which would require scheduled and recorded equipment inspection and maintenance, covering all tools, cords, and wiring on the jobsite. The public hearing on the proposal was held on December 9 and 10, 1975, in Washington, D.C., and the hearing record was certified on March 26, 1976.

In accordance with section 6(b) of the Act, Executive Order 11821 (39 FR 41501), OMB Circular No. A–107 (January 28, 1975), and Secretary's Order No. 15–75 (40 FR 54484) and administrative instructions thereto (U.S. Department of Labor Temporary Directive No. 1, No-

vember 24, 1975), OSHA assessed the technical feasibility and economic and inflationary impacts of its proposal, including the impacts of each of the alternatives mentioned in the September 2, 1975, hearing notice. On April 27, 1976, OSHA published, in the FEDERAL REGISTER (41 FR 17576), a notice certifying that none of the alternatives would be a major action which would necessitate further inflationary impact evaluation or the preparation of an inflationary impact statement. This certification was based on the economic identification criteria specified in section 5(c) of Secretary's Order No. 15–75. In addition, the notice announced the availability of the technological feasibility and economic assessment, and interested persons were given until May 27, 1976, to submit written comments on these matters.

The record of this rulemaking proceeding includes all of the evidence before the Advisory Committee in making its recommendations and all the evidence presented to the Assistant Secretary in developing the standard including comments and evidence in response to all of the aforementioned FEDERAL REGISTER notices, as well as all evidence adduced at two informal hearings. Also included in the record is the technological feasibility and economic impact assessments, and the public comment thereto. This entire record was thoroughly reviewed and evaluated in reaching the determinations set forth below and in developing this final standard.

III. PRINCIPAL ISSUES INVOLVED

The evidence submitted into the record is summarized and evaluated in the following discussions of each issue. The numbers in brackets refer to specific references in the December 9 and 10, 1975, hearing exhibits (Ex.) which included the entire record to date, hearing transcript page numbers (Tr.), and post-hearing comments (PH). The following are the principal issues involved in this rulemaking proceeding:

1. *Whether 120-volt, ground-fault accidents are occurring on construction sites in sufficient quantity to warrant regulatory attention.* The record contains descriptions of hundreds of electrocutions [Ex. 2, 5, 13, 14, 31]. Although many of the reports did not contain sufficiently detailed information to accurately determine the specifics of each electrocution, enough information was available to make a determination that approximately 70 of these fatalities were 120-volt, ground-fault electrocutions that occurred on construction sites. These accidents were reported during the years of 1970 to 1975. A review of the evidence indicates a substantial probability of greater occurrence of death, due to poor reporting and the possibility of some deaths going unreported as electrocutions because of the mistaken belief that they were caused by heart failure.

Several estimates were made of the annual number of 120-volt, ground-fault electrocutions occurring on construction sites. One commenter, using two different extrapolations of accident data, estimated the number to be 34 deaths each year [Ex. 35]. Additionally, an extrapolation of the 41 deaths found in the OSHA State Survey [Ex. 5] indicates that about 30 of these fatalities occur nationally per year.

One witness introduced data concerning electrocutions in Dade County, Florida [Tr. 112–113]. During the last 19 years, Dade County experienced a total of 105 on-the-job electrocutions which corresponds to a yearly average of 5.5. Also, the data included six ground-fault electrocutions (120-volt) on construction sites over the last 5 years, which is an average of 1.2 per year. These two averages give a 0.218 ratio. From the *Vital Statistics of the United States*, a different witness [Ex. 18 of the February 26, 1974 hearing] calculated the national average of all on-the-job industrial electrocutions to be 208. Multiplying this national average of 208 by the 0.218 ratio yields an estimate of about 45 ground-fault electrocutions on construction sites per year.

Thus four extrapolations of different data have been performed with each yielding an estimate of 30 to 45 electrocutions per year. Therefore, it appears that at least 30 such electrocutions are occurring each year on construction sites.

The accident data discussed here are those electrical accidents resulting in death, which is, of course, the most severe accident caused by 120-volt ground faults. It is abundantly clear that these deaths are occurring in sufficient numbers to warrant regulatory protection. There is evidence in the record, furthermore, that indicates the occurrence of a substantial number of nonfatal injuries for every fatality [Ex. 18 of the February 26, 1974 hearing]. These injuries, some of which are serious, also warrant regulatory action.

2. *Whether proper equipment grounding can prevent such accident on construction sites.* Present regulations in the NEC and adopted by OSHA require equipment grounding conductors for most 120-volt tools and circuits on construction sites. Essentially all of the witnesses who addressed this issue agreed that equipment grounding conductors, if used and maintained properly, are effective in preventing electrical accidents [Ex. 1, 12, 15, 26, 28, 37; Tr. 21–22, 302, 370, 429; PH 2, 51. However, a review of the evidence strongly indicates that the equipment grounding conductor is not always properly maintained, even by the most elementary precautionary procedures [Ex. 5, 14]. In addition, there is evidence that the equipment grounding conductor is often intentionally circumvented, such as by clipping the third prong or attaching a three prong plug to a two wire extension cord. Furthermore, as noted by some witnesses, tools and cords on construction sites are exposed to rough use and abuse, and the equipment grounding conductor can accidentally become discontinuous by the rough handling [Ex. 14, 35]. As a result, the effectiveness of the equipment grounding conductor can be defeated without the knowledge of the employee it is supposed to protect.

A review of the accidents also shows that many employees are not fully aware of the hazards involved in using electric tools. For example, at least three of the reports showed that employees had received shocks from equipment they were using, but continued using them until someone was electrocuted [Ex. 5, 13].

A few of the electrocutions on which evidence was submitted apparently occurred with the use of tools which were properly grounded; however, the overwhelming majority of the ones which allowed a specific determination to be made were caused by a malfunction of a part of the equipment grounding conductor [Ex. 5]. Frequently, for example, a defect in the grounding conductor, such as a break, allowed it to come into direct contact with the ungrounded conductor. However, an equipment grounding conductor alone cannot provide complete protection under all circumstances. For example, if a fault current of about 3 or 4 times the rating of the circuit breaker occurs during the use of the tool, sufficient fault current may flow through the person holding the tool and cause his electrocution before the circuit breaker could open.

Based on the evidence, including the occurrence of a significant number of ground-fault accidents and the evidence that equipment grounding conductors are, in many cases, not adequately and effectively maintained, it appears that although proper equipment grounding conductors can prevent such accidents, the existing equipment grounding conductor regulations are inadequate to provide the necessary protection. Accordingly, OSHA concludes that there is a need to supplement the existing equipment grounding conductor requirements to adequately protect employees from ground-fault accidents resulting in injuries and fatalities.

3. *Whether GFCI's can supplement the present equipment grounding conductor requirements to prevent such accidents on construction sites.* The ground-fault circuit interrupter is a fast-acting device which senses small current leakage to ground and, in a fraction of a second, shuts off the electricity and "interrupts" its faulty flow to ground. Placed between the electrical service and the tool it serves, the GFCI continually matches the amount of current going to and from the tool along the normal path of the circuit conductors. Whenever the amount "going" differs from the amount "returning" by a set trip level, 5mA ± 1mA on currently approved GFCI's, the GFCI interrupts the electric power within $\frac{1}{40}$ of a second. This difference in current is called leakage current to ground and the path it takes to ground could be through a person—in which case, the rapid response of the GFCI is fast enough to prevent electrocution. This protection provided by the GFCI is independent of the condition of the equipment grounding conductor. Thus, the GFCI can provide protection even where

the equipment grounding conductor has become ineffective.

By relating the capability of a GFCI to the facts reported concerning the accidents described in the record [Ex. 2, 5, 13, 14, 31], it can be shown that GFCI's could have prevented nearly all of the 120-volt, ground-fault electrocutions. For example, one construction site fatality occurred after the victim had mistakenly connected the "hot" conductor to a cord connector's equipment grounding conductor terminal in trying to repair an extension cord. Upon plugging the portable saw into the cord, he was electrocuted [Ex. 5]. If a GFCI had been in use, it would have detected and interrupted the current flow from the energized tool through the man to ground. Another construction worker was electrocuted when he picked up a new electric hand tool [Ex. 5]. All the cords were properly wired, but an altered plug on one of the extension cords he was using was inserted into a receptacle with the plug's grounding prong in contact with the "hot" conductor's terminal. The use of a GFCI could have similarly prevented this accident. Still another construction worker was electrocuted as he was helping a coworker install metal studs [Ex. 5]. The extension cord that the coworker was using had portions where bare conductors were exposed by insulation damage. When the coworker pulled on the extension cord, one of the bare spots hit the metal stud on which the victim was leaning. A ground-fault current then flowed from the exposed conductor through the metal stud (which was in contact with it), through the worker (who was leaning on the stud), and back to ground through the properly grounded screw gun he was holding. The use of a GFCI could also have prevented this electrocution.

Some witnesses stated that GFCI's do not provide the same degree of protection against ground faults as equipment grounding [Ex. 12, 28; PH 5]. These witnesses pointed out that, since GFCI's allow a fault current to pass to ground for 1/40 of a second before tripping, GFCI's do not prevent electric shock and the secondary injuries which can result from such shock [Ex. 12; PH 5]. They also contended that equipment grounding prevents electric shock and provides greater protection to employees against ground fault [Ex. 28; PH 5]. However, a requirement for GFCI's would be in addition to, not in lieu of, the equipment grounding conductor requirements and would serve as backup protection in circumstances when the equipment grounding conductor does not provide protection.

4. *Whether GFCI's can be successfully used on construction sites.* Experience using GFCI's under varying weather and jobsite conditions was reported into the record by State and local electrical inspectors [Ex. 3, 7, 8, 9, 10, 11], various contractors and contractor associations [Ex. 2, 3, 4, 12, 28; Tr. 274–276, 283–284, 287–289, 293], Federal agencies [Ex. 2, 3], an electric utility [Ex. 27], and others [Ex. 14]. In general, the contractors claimed that GFCI's were unsuitable for use on construction sites due to "nuisance tripping," which resulted in downtime. Others, including Federal and local government authorities who have enforced the GFCI requirement on a local level based on their adoption of the NEC, reported that the devices could be used successfully with proper installation and maintenance of electrical tools and circuits.

The term "nuisance tripping," as used throughout the rulemaking proceeding, connoted two categories of GFCI tripping: (1) "false trips," i.e., trips due to such causes as malfunctioning GFCI's or electromagnetic interference; and (2) "intended trips" caused by leakages in excess of the trip level. This distinction should be clearly understood. The term "nuisance tripping" by itself is imprecise and often misleading, since all tripping may, in fact, be considered a nuisance. Yet, with this distinction in mind, "intended tripping" reflects the proper operation of the GFCI and indicates either a hazard to employees or misapplication of the GFCI which can be remedied.

The aggregate experience of the hearing witnesses and commenters demonstrates that tripping is caused by: (1) Wet cord connectors and tools; (2) Tools and cords in poor condition (especially in wet environments) or faulty tools and cords; (3) Extremely long circuits (over 500 ft.); (4) Too many tools on one GFCI; (5) Improper installation of a GFCI (such as a single pole GFCI on a multiwire circuit); (6) Faulty GFCI's; (7) Electromagnetic interferences; and (8) Power line transients.

The first two pose a serious hazard to the employee and the next three are misapplications of the GFCI. Trips due to these five causes are therefore "intended tripping." Therefore, with the elimination of improper GFCI usage, all intended trips would result from and be indications of hazardous conditions. Only the tripping caused by the last three, on the other hand, are "false tripping." The problems of "false tripping" caused by the last two items have apparently been overcome by the affected manufacturers [Ex. 1, 14; Tr. 338; PH 3]. (Some makes were not susceptible to either type of tripping [Tr. 443].)

Some commenters suggested that a trip level of 5mA was too low and contributed to the "nuisance tripping." These commenters suggested that trip levels of 15 or 20mA, or even 30mA, would be more appropriate. However, there is uncontroverted evidence in the record showing the "let-go" current threshold for construction workers to be 9mA [Ex. 2; Tr. 77]. (This "let-go" threshold is the current at which some of the people could not let go of an energized object held in the hand, possibly resulting in an injury or fatality in the absence of some form of protection.) Increasing the trip level would therefore increase the probability of a worker's being injured in spite of the use of a GFCI, because a hazardous ground-fault current which is less than the "higher" trip level but greater the "let-go" threshold can, in fact, occur. Furthermore, the trip level has a negligible effect on the sensitivity of a GFCI to "false tripping," and there is evidence in the record that increasing the trip level to 10 or 15mA (both of which are beyond the "let-go" threshold) would have a minor effect on the incidence of "intended tripping" [Ex. 27; Tr. 178, 197, 355]. Therefore, since increasing the trip level would not significantly reduce the incidence of tripping but would expose a worker to an increased probability of being injured, OSHA has concluded that a trip level of 5mA (with a tolerance of ±1mA) is feasible and necessary for the protection of employees.

Much of the evidence submitted on the frequent tripping of GFCI's was based on the use of earlier models with trip levels from 2.2mA to 5mA. However, the trip level of currently manufactured GFCI's is now 5mA ± 1mA, which will eliminate nonhazardous tripping from leakages less than 4mA [Tr. 16–17, 21]. Furthermore, the evidence submitted by the Puget Sound Power & Light Company indicated that all the trips experienced in their latest study were "intended" trips, because the leakages were, in fact, greater than 4mA [Ex. 27].

Some hearing witnesses claimed that tripping from wet tools and connectors caused serious downtime problems and called this "nuisance tripping." They also claimed that wet tools and connectors posed no hazard [Ex. 28; Tr. 311, 317–319, 371–378]. However, with a cord connector in wateer, hazardous leakages can develop not only to the equipment grounding conductor but to anyone who picks up that connector and provides a path to ground. This leakage is not limited to the face of the connector but also develops to any wetted portion of it.

Additionally, tools with high leakage currents (greater than 5mA), which might be caused, for example, by a build up of carbon or other conductive particles inside the tool, also represent hazards. If the leakage is below approximately one ampere and the equipment grounding conductor is of a low resistance, no shock should be perceived. However, since the body provides a parallel path to ground through which leakage current passes, the current flow through the body increases with increasing grounding conductor resistance. Thus, if the resistance of the equipment grounding conductor is significantly greater than 1 ohm or is intermittent, even tools with small leakages become hazardous.

The evidence also showed that the amount of tripping can be reduced by certain practices and procedures which in many cases also help reduce the hazard. Triping caused by wet connectors and tools can be reduced by not exposing them to excessive moisture [Ex. 7, 12, 14] and by using waterproof or sealable connectors [Ex. 7, 14; Tr. 310–311]. Tools and connectors can also be cleaned, replaced, or repaired, if necessary, to reduce tripping [Ex. 7, 12, 14; Tr. 200]. Providing more GFCI's can prevent tripping caused by the cumulative leakage of several tools, and locating them closer to the workmen can prevent tripping caused by leakages from extremely long

circuits [Ex. 14; Tr. 467–468]. In addition, many jurisdictions reported that after initial problems of excessive tripping, utilization of the above procedures eliminated the difficulties. In light of the above, OSHA believes that GFCI's can be successfully used on construction sites without excessive tripping, if certain practices and procedures are utilized. Furthermore, OSHA concludes that the use of GFCI's on construction sites will work to significantly reduce the amount of ground-fault accidents, and that it is technologically feasible to use them without interference with the normal safe operation of the jobsite.

5. *What is the estimated cost of implementing the requirement for GFCI's on construction sites?* The commenters used various methods of estimating either their own costs or those of the entire industry. Two large companies gave estimates of their own projected installation expenditures if GFCI's were required on construction sites [Ex. 12, 15]. Using these estimates and 1974 construction values (all the estimates in this section are based on 1974 construction values which were the latest figures available), an installation cost of 30 to 40 million dollars can be extrapolated for the construction industry. An electrical contractor's association estimated an installation cost of $34.5 million based on the increase in the cost of temporary wiring [Ex. 28]. These commenters estimated an additional cost of 1 to 2 times the cost of installation for annual maintenance expenses. These include the costs of lost production due to tripping, "extra" maintenance of tools, cords, and connectors, and replacement costs. However, among contractors, maintenance costs would vary in inverse proportion to the effort expended to reduce "intended" tripping from improper electrical installations and defective tools.

Another trade association estimated an initial cost of complying with a standard requiring GFCI's to be $10.3 million for approximately 70 percent of its membership [Tr. 299]. Based on 70 percent of the association's 1975 construction receipts [PH 5], this can be extrapolated to about $40 million for the entire construction industry.

By using a hypothetical building project as a model, a witness estimated that installing GFCI's would add approximately 0.05 percent to 0.06 percent to the cost of non-residential construction [Ex. 13]. Using 0.06 percent as a basis for projecting the cost for the entire construction industry, the initial cost for installing GFCI's is $80.9 million. However, the witness' assumptions lead to an over-estimation of the cost. For example, his assumptions call for a one-to-one relationship of GFCI's to employees using handtools, but other witnesses were assuming a more realistic ratio of at least two employees per GFCI [Ex. 12; Tr. 282]. Dividing the estimate of $80.9 million by a factor of two brings it into line with the other estimates of initial cost.

All of these cost estimates are, therefore, in the range of 30 to 40 million dollars for the installation of GFCI's and an additional expense of 1 to 2 times this amount for maintenance. The total cost would then average $87.5 million for the first year. However, some of the costs included in the maintenance expenses are those needed to bring tools and cords into compliance with current safety standards. Therefore, some of these maintenance costs are not attributable to the requirement for GFCI's. Furthermore, as experience is gained, these maintenance costs would be further reduced by using improved techniques and equipment.

The "Ground-Fault Circuit Protection, Preliminary Assessment of Technological Feasibility and Economic Impacts" prepared for OSHA by Arthur Young and Company estimated the annualized cost (annual cost plus 20% of the initial cost) to be as high as $73.5 million. This estimate generally agrees with the previous extrapolations of the witnesses' data.

In response to the request for comments on this assessment, one of the hearing participants submitted (comment 8) an estimated annual cost of about $600 million for GFCI's. This estimate included seven component factors, one of which was an annual "spurious" tripping cost of $540 million, based on a trip rate of 18.57 trips per GFCI per year and a cost of $30 per trip for a total of 1 million GFCI's. However, it appears that the trip rate of 18.57 is based on an unrepresentative installation, which experienced excessive tripping from electromagnetic interference—a problem which has since been corrected in newer-model GFCI's. Furthermore, this same company on a different construction site, which utilized a different type GFCI that protects two circuits and that was not subject to "false" tripping, experienced only 10.2 trips per GFCI per year [Tr. 283]. This is equivalent to a 5.1 trip rate for GFCI's which protect only one circuit, and is consistent with the 5.2 trip rate which was experienced by another witness' company [Ex. 12] and which was utilized in the preliminary assessment. Additionally, the $30 per trip cost submitted in comment 8 is a substantial over-estimate. This commenter claimed that 10 workers would be idled for each trip at a cost of $12 per hour per worker. This estimate appears to be too high. We think that a better estimate of the cost of idling workers would be based on the evidence that in 1974, the average construction worker earned about $6.77 per hour (Statistical Abstract of the U.S., 1974), and assuming a 25 percent add-on for increases and fringe benefits, his total compensation would be about $8.50 per hour. Normally, only two or three power tools can be accommodated by a 15- or 20-ampere circuit without overload; and, therefore, only two to three employees would thus be $91 million, and not $600 Using this commenter's estimate of 15 minutes of downtime per trip, the tripping cost would be about $5 per trip. These more representative numbers (a 5.2 trip rate and $5 per trip cost) would then yield an annual spurious tripping cost of $26 million rather than $540 million. Without correcting the other six component factors, in comment 8, which were also high, the annual cost of GFCI's would thus be $91 million, and not $600 million, for the construction industry.

Additionally, the hearing testimony and comments indicated that a significant number of jurisdictions already require GFCI's on construction sites [Ex. 7; Tr. 47]. In these jurisdictions, the contractors have presumably installed GFCI's, and no further expense would be incurred by an OSHA ground-fault protection requirement. This factor was not considered in any of the estimates and would also tend to reduce the expenditures needed to comply with an OSHA standard requiring GFCI's. However, though it would appear to have a significant effect, this factor cannot be precisely calculated.

6. *Whether there is a method other than GFCI's of supplementing the present equipment grounding conductor requirements to prevent 120-volt, ground-fault accidents on construction sites.* The notice of hearing discussed alternatives to GFCI's and indicated that OSHA was considering the possibility of requiring, as an alternative to GFCI's, a scheduled and recorded equipment inspection and maintenance program. Much evidence was received on this possibility.

Some of the witnesses stated that their safety records demonstrated that GFCI's were not needed to protect their employees from electrical hazards [Ex. 12, 15; Tr. 300–302]. These companies, however, maintain their electrical equipment with regular inspections and tests and have training programs to educate their employees in electrical safety [Ex. 12, 15; Tr. 276–277, 307]. Therefore, the witnesses claimed that an alternative means of protection from 120-volt, ground-fault hazards could be provided by an assured equipment grounding conductor program [Ex. 1, 12, 15].

Several companies and contractor associations submitted statistics on their experiences on construction sites using similar programs. For example, one association reported over 1.3 billion man-hours of construction work (which is equivalent to about ⅛ of one year's total construction man-hours) with only 69 incidents involving contact with 120 volts [Tr. 300–301]. These 69 contacts resulted in four lost-time injuries and one fatality, which they claimed could not have been prevented by the use of a GFCI. One company reported a construction experience of 500 million man-hours with one lost-time injury and no fatalities [Ex. 12]. In both examples, the companies involved regularly check their tools and cords for compliance with OSHA's standards for proper equipment grounding [Ex. 12; Tr. 307]. The experience of these companies is that an assured equipment grounding conductor program is effective in preventing 120-volt, ground-fault accidents. Additionally, the chairman of an NEC technical subcommittee on the requirements for ground-fault circuit protection for personnel presented his recommendation that an assured equipment grounding

conductor program be accepted as an alternative to GFCI's [Tr. 430–433, 440–441].

Some witnesses claimed that an assured equipment grounding conductor program does not provide the same measure of safety as the use of GFCI's [Ex. 14]. The argument presented in support of this view is that an assured equipment grounding conductor program would include only periodic checks of the condition of the equipment, whereas a GFCI affords continuous monitoring of the equipment [Ex. 14; Tr. 133–134]. Therefore, it is argued that an assured equipment grounding conductor program might not protect employees when the equipment grounding conductor malfunctions subsequent to testing of the equipment. While it may be technically true that defects in the equipment grounding conductor can develop after the equipment has been tested, nearly all defects can be spotted as they develop through inspection and testing. In addition, there has been no showing that a greater incidence of accidents has been experienced when an assured equipment grounding conductor program has been implemented than with the use of GFCI's.

An analysis of the accident data leads OSHA to the conclusion that most of the 120-volt, ground-fault accidents which have occurred could have been prevented either by the use of GFCI's or by the implementation of an assured equipment grounding conductor program. For example, one construction site fatality occurred after the victim had mistakenly connected the "hot" conductor to a cord connector's equipment grounding conductor terminal in trying to repair an extension cord. Upon plugging the portable saw into the cord, he was electrocuted [Ex. 5]. If an assured equipment grounding conductor program had been implemented, the extension cord would have been tested after its "repair." In testing the cord, the defect would have been detected and the accident would have been prevented. Another construction worker was electrocuted when he picked up a new electric hand tool [Ex. 5]. All the cords were properly wired, but an altered plus on one of the extension cords he was using was inserted into a receptacle with the plug's grounding prong in contact with the "hot" conductor's terminal. Still another construction worker was electrocuted as he was helping a coworker install metal studs [Ex. 5]. The extension cord that the coworker was using had portions where bare conductors were exposed by insulation damage. When the coworker pulled on the extension cord, one of the bare spots hit the metal stud on which the victim was leaning. A ground-fault current then flowed from the exposed conductor through the metal stud (which was in contact with it), through the worker (who was leaning on the stud), and back to ground through the properly grounded screw gun he was holding. If an assured equipment grounding conductor program had been implemented on the construction sites where these last two workers were killed, the daily inspections would have readily detected these defects (the altered plug in one case and the insulation damage in the other), before the accidents occurred.

Although enabling us to reach the conclusion that either method of protection, GFCI's or assured equipment grounding conductor programs, is highly effective, the accident data does not allow a determination of whether either method is more effective in protecting against ground-fault hazards. What the record does show is that the accident experience of companies, which have implemented assured equipment grounding conductor programs for a number of years, has been that very few accidents have actually occurred on their construction sites. Moreover, since proper equipment grounding could prevent nearly all of the 30 to 45 ground-fault electrocutions occurring annually, and since assured equipment grounding conductor programs have been shown to actually result in the proper maintenance of the equipment grounding conductor, OSHA concludes that these electrocutions can be prevented by the use of an assured equipment grounding conductor program.

7. *What are the appropriate elements of an assured equipment grounding conductor program?* The recommended type of assured equipment grounding conductor programs necessary to provide safety to the employee did not vary substantively among the majority of the witnesses. They generally agreed that the equipment grounding conductor had to be tested [Ex. 1, 12, 14, 15, 26, 34, 36, 37] and that the program did not have to be lengthy or complex [Ex. 15, 37; Tr. 432, 435]. Some witnesses recommended more tests than others. Among the tests recommended were:

1. A continuity test of the equipment grounding conductor;
2. A test for short circuits;
3. A test to determine the adequacy of the equipment grounding conductor, by passing a high current through it;
4. A resistance test of the equipment grounding conductor; and
5. A leakage test (for tools only).

Of these OSHA feels that to ensure the safe condition of the equipment grounding conductor for tools, extension cords, or power supplies only the continuity test is necessary. The presence of the equipment grounding conductor is the parameter which is essential in providing the intended safety of the assured equipment grounding conductor program. The remaining tests evaluate properties of the equipment other than the presence of the equipment grounding conductor. Additionally, a test ascertaining that the equipment grounding conductor is connected to its proper terminal should be conducted. These two tests would assure that the equipment grounding conductor is present.

Other factors these witnesses considered necessary in an assured equipment grounding conductor program included:

1. The procedure for the program should be in writing;
2. A person responsible for carrying out the program should be designated;
3. Tests should be performed on receptacles, cord sets, and equipment connected by cord and plug (which is required to be grounded);
4. The testing should be recorded;
5. The testing should be performed before first use, after repairs are made, after suspected damage has occurred, and at regular intervals (generally three months); and
6. Visual inspections for damage should be performed before each day's use of a tool or cord.

OSHA concludes that an assured equipment grounding conductor program, in order to be effective, must include all of these elements. Those employers who have successfully used a program of this nature have incorporated most or all of these elements into their programs. Testing of receptacles, cord sets, and equipment connected by cord and plug is necessary since this equipment, on construction sites, is subject to abuse and the equipment grounding conductor may become inoperative. Since the equipment grounding conductor could be inoperative in a new tool, an improperly repaired tool, or a damaged tool, testing is essential before first use, after repair, and after damage is suspected. Since ordinary usage of a tool may affect the integrity of the equipment grounding conductor, OSHA believes that periodic testing is necessary. Several witnesses recommended that this testing take place every three months, and every six months for cord sets and receptacles which are essentially fixed [Ex. 12; Tr. 14, 432]. This evidence was uncontroverted. The visual inspection, which will usually be conducted by the user of the tool, is designed to detect the obvious type of damage such as missing pins, frayed wires, or damaged insulation. This daily inspection will not only detect obvious defects, thus preventing accidents, but will also hopefully raise the awareness of the employees toward the hazards associated with their electrical tools. The written procedure, designation of responsibility, and recording of the tests are necessary administrative requirements which ensure the effective implementation of the assured equipment grounding conductor program.

Some commenters also indicated that training of employees is an important aspect of alerting employees to the hazards associated with the use of electricity. We agree that training in the hazards of electricity and the safe use of electrical connectors and tools is necessary for the protection of employees. We have not, however, included a specific requirement for a training program as part of the assured equipment grounding conductor program since the general training requirements in § 1926.21(b)(2), which requires employers to instruct employees in the recognition and avoidance of unsafe conditions, were considered to be applicable to the subject of electrical hazards and adequate to impose an obligation for the requisite training.

8. *Whether it is feasible to implement an assured equipment grounding conductor program on construction sites.* Some witnesses asserted that an assured equipment grounding conductor program was impractical and unworkable on construction sites [Tr. 277–278, 391; PH 5]. One witness based his assertion on his company's experience with a similar program implemented on a large industrial construction site [Tr. 277–278]. Due to the size of the site, the large number of employees, and the variety of color bands simultaneously displayed on different tools (color bands being one method of recording tests), this witness seriously questioned whether this program, which was required by Federal contract, was actually in compliance with the contract.

In contrast, considerable evidence has been submitted of successful application of assured equipment grounding conductor programs. Representing a large company, one witness indicated successful use of a system of assured equipment grounding since 1935 [Ex. 12]. This company has found a three-month test interval and a system of colored banding (as a test record) to be satisfactory. A large chemical company uses a program that includes "checking tools on leaving and coming back to the tool bins" [Tr. 260]. Still another large chemical company, in its construction activities, devotes its resources to installing and maintaining effective equipment grounding conductors [Ex. 37]. Additionally, representatives from two large industrial associations state that many of their member companies also have programs to assure proper equipment grounding [Ex. 26, 36]. In light of the overwhelming evidence of actual experience, OSHA concludes that it is feasible to implement such a program on construction sites.

9. *What is the estimated cost of implementing an assured equipment grounding conductor program?* One witness, whose company's construction volume was $1 billion, estimated the cost of an assured equipment grounding conductor program to his company to be $120,000 [Ex. 12; PH 2]. In the 1975 Statistical Abstract of the United States, the value of all U.S. construction was $135 billion for 1974. Extrapolating this witness' estimate to the entire construction industry, the cost to perform the tests for tools and cords would be $16.2 million. In addition, the cost of the equipment to perform the tests varies between 19.8 and 27.6 million dollars. This range is based on the use of either a specialized tester or the use of standard testers. Based on the estimate that one specialized tester, costing approximately $500, would be used for every 100 tools and that there is one tool for each of the 4,000,000 construction employees, the total initial procurement cost for this tester would be approximately $19.8 million. However, use of standard testers (with a cost of $10 for a receptacle tester and $20 for an ohmmeter) by each of the 920,000 contractors in the U.S. would result in an initial cost of about $27.6 million. Therefore, the total first year cost (of testing and test equipment) could range from 36.0 to 43.8 million dollars.

IV. Conclusions

OSHA is faced with three alternatives in making its decision on ground-fault protection for personnel on construction sites—revoking the requirements for GFCI's entirely, requiring GFCI's or requiring either GFCI's or an assured equipment grounding conductor program. The evidence submitted on the subject of ground-fault circuit interrupters is sufficient to provide a basis for this determination to be made. The record has clearly demonstrated that 120-volt, ground-fault accidents are occurring on construction sites in sufficient quantity to deserve attention. OSHA feels that the 30 to 45 deaths per year, and the numerous secondary accidents, that are attributible to ground-faults strongly indicate a definite need for regulatory action to provide employee protection. Clearly, the record demonstrates that the use of GFCI's can feasibly and effectively supplement the present equipment grounding conductor requirements in preventing these accidents. Furthermore, the evidence shows that GFCI's can be used successfully on construction sites, if certain practices and procedures are utilized. These include not exposing cord connectors or tools to water and providing a sufficient number of GFCI's.

The evidence also indicates that proper equipment grounding can prevent such accidents. However, unless they are properly maintained and regularly checked, equipment grounding conductors may become discontinuous or ineffective, without this condition becoming readily apparent to the employee using the equipment. Based on the record, we have concluded that the proper maintenance and checking can be provided by an assured equipment grounding conductor program, and that such a program can be an effective and feasible method of preventing electrical accidents from cord- and plug-connected equipment. These programs include regularly testing the equipment grounding conductors of receptacles, cord sets, and equipment.

Our decision to permit employers to select either GFCI's or the assured equipment grounding conductor program as the means of providing the necessary protection for employees is based on our conclusion from the evidence that both means provide approximately the same margins of safety. Both methods work, in the sense that they are technically sound ways of preventing ground-fault accidents and could have prevented nearly all of the electrocutions discussed in the record. Both procedures, however, also have their technical or practical deficiencies. For example, GFCI's do not prevent electric shock and, while they will trip before the employee is electrocuted, the employee experiencing the shock may still suffer a serious, even fatal, secondary injury as a result of the recoil from the shock. GFCI's are also subject to failure and to being by-passed. The assured equipment grounding conductor program also has deficiencies. For example, it requires careful attention of the person(s) responsible for its implementation, and it cannot totally eliminate the possibility that the equipment grounding conductor may suddenly fail or be bypassed. Additionally, in a small number of cases, the equipment grounding conductor may not provide adequate safety. The evidence in the record is not sufficiently detailed, nor do we think evidence could presently be obtained, to permit a precise calculation of the greater effectiveness of one method over the other; however, based on the evidence and the foregoing discussion, we conclude that the difference in effectiveness, if it exists at all, is very small. Furthermore, while the proposal and notice of hearing did not specifically raise the possibility of requiring the use of both GFCI's and an assured equipment grounding conductor program, this option is viewed as providing a speculative and, at most, marginal improvement in safety while imposing a substantially greater burden on employers.

It is clear that the overriding purpose of the Act is to protect employee safety and health even if such protection results in the expenditure of large sums of money, increased production costs or reduced profit margins. On the other hand, the Act is not intended to impose unnecessary financial or other burdens upon affected employers. In light of the total value of construction (which exceeds $135,000,000,000 per year), however, the standard will not have a major economic or inflationary impact. Furthermore, in view of the number of 120-volt, ground-fault electrocutions occurring on construction sites (which is estimated to be between 30 and 45 per year) and other injuries incurred, the cost of compliance is justified.

As noted, OSHA has determined that the use of assured equipment grounding conductor programs on construction sites can be as effective in preventing 120-volt, ground-fault accidents as the use of GFCI's. Since an equivalent margin of safety can be afforded by the use of either method of protection, OSHA believes that it is appropriate to permit the employer to select either GFCI's or an assured equipment grounding conductor program on construction sites. In our view, permitting the employer this alternative, where safety is not being sacrificed, better effectuates the purposes of the Act within the meaning of section 6(b)(8) than would a requirement that all employers install GFCI's as required by the 1971 NEC. Several reasons lead to this conclusion. OSHA believes that, to the extent possible, its regulations should not inhibit technological development by mandating the implementation of specific devices or means of achieving safety where other means are available which are equally effective. Providing employers with a choice also encourages employer compliance with the standard and thereby eases enforcement as well. Many employers who already have an assured equipment grounding conductor program in effect or who already use GFCI's will

be able to comply with this standard with only minor adjustments in their methods of operation. This will give appropriate consideration to those who have taken steps to protect their employees and will encourage such action by other employers in the future. Even as to employers who do not now have an assured equipment grounding conductor program or do not use GFCI's, providing a choice of methods of protection will encourage compliance by easing the burden on employers without sacrificing safety. Thus, an employer may choose one method of protection or the other on the basis of several factors. The individual employer may choose on the basis of cost; if his local jurisdiction already requires GFCI's, he may choose GFCI's; if he is one employer of many on a construction site, the availability of alternatives gives him a flexibility to coordinate compliance. Another factor considered by an employer could be the size of his operation—a smaller employer may opt for the purchase of one or more portable GFCI's while a larger employer might pick the assured equipment grounding conductor program. OSHA believes that offering such a choice will encourage compliance by employers and therefore result in greater safety.

Finally, there is evidence which indicates that the code making authorities responsible for the revision of the NEC are currently considering amending the pertinent consensus standard to permit the same alternative means of protection as the ones being permitted in the standard promulgated herein.

Based on the record as a whole, OSHA has determined that a ground-fault protection standard is necessary and appropriate for the safety and health of employees. Therefore, OSHA is promulgating a rule requiring employers to provide either: (a) Ground-fault circuit interrupters on construction sites, or (b) a scheduled and recorded, assured equipment grounding conductor program covering receptacles, cord sets, and cord- and plug-connected equipment used on construction sites.

V. Discussion of the Final Standard

Following is a discussion of the major aspects of the final standard. Employers are required by the final standard to provide at least one of two ground-fault protection methods on construction sites, in addition to complying with the applicable equipment grounding conductor requirement contained in the OSHA regulations. Each method is discussed separately as follows:

1. *Ground-fault Circuit Interrupters* (*§ 1910.309(c)(2); § 1926.400(h)(2)*. If the employer selects this option, the employer must provide ground-fault circuit interrupter protection for all 120-volt, 15- and 20-ampere, single-phase receptacles on construction sites, which are not a part of the permanent wiring of the building or structure and which are in use by employees. As noted, this protection is required in addition to, not in lieu of, the equipment grounding conductor requirements of Parts 1910 and 1926.

The GFCI's used must be "approved," as that term is defined in §§ 1910.308(d) and 1926.405(a). Various types of approved GFCI's suitable for use on construction sites are available, including circuit-breaker, receptacle, and portable types. Most of today's approved GFCI's have trip levels of 5mA ± 1mA. Portable GFCI's are acceptable, if they are connected to the receptacle outlet in use.

On generators whose supply wires are not required to be grounded, and are in fact not grounded, the return path for a ground-fault current to flow is not completed and the hazard which a GFCI would protect against is not present. Consequently, the rule as promulgated in § 1910.309(c)(2) and § 1926.400(h)(2) does not require the use of GFCI's on portable or vehicle-mounted generators of 5kW capacity or less if its output is a two-wire, single-phase system and its circuit conductors are insulated from the generator frame and all other grounded surfaces. This section is similar to the provisions of the 1975 NEC, section 210-8(b). It should be noted that receptacles on all small portable generators are not exempt from the GFCI requirement. The standard clearly states that receptacles on such generators, to be exempt, must have the circuit conductors insulated from the generator frames and all grounded surfaces. The requirements of section 445-8 of the 1971 NEC (adopted by reference in § 1910.309 and § 1926.400(a)) also, of course, apply to such generators.

2. *Assured Equipment Grounding Conductor Program* (*§ 1910.309(c)(3) and § 1926.400(h)(3)*). If the employer selects this option, the employer must provide an assured equipment grounding conductor program covering all cord sets, receptacles which are not a part of the permanent wiring of the building or structure, and equipment connected by cord and plug which are available for use by employees. The requirements which the program must meet are set forth in §§ 1910.309(c)(3) and 1926.400(h)(3), but employers may provide additional tests or procedures. Though it is not required to be posted, a written procedure for the program shall be kept at the jobsite and made available to OSHA and any affected employee.

The employer must designate one or more competent persons to implement the program: A competent person is defined in § 1926.32(f) as one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them. This person may be the employer, an employee of the employer, or another person.

Inspections. Equipment, except cord sets and receptacles which are fixed and not exposed to damage, must be inspected, before each day's use, for visible damage or defects. Any equipment found on inspection to be damaged or defective may not be made available for use or used by employees.

Periodic Tests. Two tests are required to be performed to assure the safe condition of the equipment grounding conductor. The first test is a continuity test—the equipment grounding conductor must be electrically continuous. This test is required to be performed on all cord sets, receptacles which are not a part of the permanent wiring of the building or structure, and cord- and plug-connected equipment which are required to be grounded. It may be performed by an ohmmeter for cord sets and cord- and plug-connected equipment, and by a receptacle tester for receptacles or by any other testing device which can ascertain electrical continuity.

In addition to the continuity test, a test must be performed on receptacles and attachment caps and plugs to ascertain that the equipment grounding conductor is connected to its proper terminal. This test can be performed by the same equipment used to perform the first test.

Both of these tests are required to be performed: (1) Before first use; (2) after any repairs; (3) after damage can be reasonably suspected to have occurred; and (4) at 3 month intervals. For cord sets and receptacles which are fixed and not exposed to damage which rough handling or abuse is most likely to cause, the testing frequency may be reduced to once every six months. The basis for the different testing interval is that this type of equipment, once it is in place, is not subject to the same abuse, and the hazards thereby created, as equipment that is constantly moved around on construction sites. Therefore, cord sets which we would consider fixed would only be those which, once they are put in place, remain stationary and not those cord sets which are being constantly moved around on construction sites.

Recording of testing. The standard requires that the testing be recorded. To record the tests, color coding, logs, or other effective means may be used. The record must indicate which equipment passed the test and the date it was tested or the interval for which it was tested. Any equipment which fails to pass the required tests may not be made available for use by employees until the defect has been repaired and the equipment successfully retested.

3. *Effective Date.* In order to allow a period for employers and employees to be informed of the existence and requirements of this standard, the effective date of the standard is February 22, 1977.

VI. The Final Standard

Accordingly, upon consideration of the whole record of this proceeding, and pursuant to sections 6(b) and 8(c) of the Occupational Safety and Health Act of 1970 (84 Stat. 1593, 1599; 29 U.S.C. 655, 657), section 107 of the Contract Work Hours and Safety Standards Act (83 Stat. 96; 40 U.S.C. 333), Secretary of Labor's Order No. 8-76 (41 FR 25059), and 29 CFR Part 1911, Parts 1910 and

1926 of Title 29, Code of Federal Regulations, are hereby amended as follows:

1. In 29 CFR Part 1910, paragraph (c) of § 1910.309 is revised to read as follows:

§ 1910.309 National Electrical Code.

* * * * *

(c) *Ground-fault protection*—(1) *General.* Notwithstanding the provisions of paragraphs (a) and (b) of this section, the requirement in section 210–7 of the 1971 National Electrical Code (NFPA 70–1971; ANSI C1–1971) that all 15- and 20-ampere receptacle outlets on single-phase circuits for construction sites have approved ground-fault circuit protection for personnel does not apply. In lieu thereof, the employer shall use either ground-fault circuit interrupters as specified in paragraph (c)(2) of this section or an assured equipment grounding conductor program as specified in paragraph (c)(3) of this section, to protect employees on construction sites. These requirements are in addition to any other requirements for equipment grounding conductors.

(2) *Ground-fault circuit interrupters.* All 120-volt, single-phase, 15- and 20-ampere receptacle outlets on construction sites, which are not a part of the permanent wiring of the building or structure and which are in use by employees, shall have approved ground-fault circuit interrupters for personnel protection. Receptacles on a two-wire, single-phase portable or vehicle-mounted generator rated not more than 5kW, where the circuit conductors of the generator are insulated from the generator frame and all other grounded surfaces, need not be protected with ground-fault circuit interrupters.

(3) *Assured equipment grounding conductor program.* The employer shall establish and implement an assured equipment grounding conductor program on construction sites covering all cord sets, receptacles which are not a part of the permanent wiring of the building or structure, and equipment connected by cord and plug, which are available for use or used by employees. This program shall comply with the following minimum requirements:

(i) A written description of the program, including the specific procedures adopted by the employer, shall be available at the jobsite for inspection and copying by the Assistant Secretary and any affected employee.

(ii) The employer shall designate one or more competent persons (as defined in 29 CFR 1926.32(f)) to implement the program.

(iii) Each cord set, attachment cap, plug and receptacle of cord sets, and any equipment connected by cord and plug, except cord sets and receptacles which are fixed and not exposed to damage, shall be visually inspected before each day's use for external defects, such as deformed or missing pins or insulation damage, and for indication of possible internal damage. Equipment found damaged or defective may not be used until repaired.

(iv) The following tests shall be performed on all cord sets, receptacles which are not a part of the permanent wiring of the building or structure, and cord- and plug-connected equipment required to be grounded:

(A) All equipment grounding conductors shall be tested for continuity and shall be electrically continuous.

(B) Each receptacle and attachment cap or plug shall be tested for correct attachment of the equipment grounding conductor. The equipment grounding conductor shall be connected to its proper terminal.

(v) All required tests shall be performed:

(A) Before first use;

(B) Before equipment is returned to service following any repairs;

(C) Before equipment is used after any incident which can be reasonably suspected to have caused damage (for example, when a cord set is run over); and

(D) At intervals not to exceed 3 months, except that cord sets and receptacles which are fixed and not exposed to damage shall be tested at intervals not exceeding 6 months.

(vi) The employer may not make available or permit the use by employees of any equipment which has not met the requirements of this paragraph (c)(3) of this section.

(vii) Tests performed as required in this paragraph shall be recorded. This test record shall identify each receptacle, cord set, and cord- and plug-connected equipment that passed the test, and shall indicate the last date it was tested or the interval for which it was tested. This record shall be kept by means of logs, color coding, or other effective means, and shall be maintained until replaced by a more current record. The record shall be made available on the jobsite for inspection by the Assistant Secretary and any affected employee.

2. In 29 CFR Part 1926, paragraph (h) of § 1926.400 is revised to read as follows:

§ 1926.400 General requirements.

* * * * *

(h) *Ground-fault protection.*—(1) *General.* Notwithstanding any other provision of this part, the requirement in section 210–7 of the 1971 National Electrical Code (NFPA 70–1971; ANSI C1–1971) that all 15- and 20-ampere receptacle outlets on single-phase circuits for construction sites have approved ground-fault circuit protection for personnel does not apply. In lieu thereof, the employer shall use either ground-fault circuit interrupters as specified in paragraph (h)(2) of this section or an assured equipment grounding conductor program as specified in paragraph (h)(3) of this section, to protect employees on construction sites. These requirements are in addition to any other requirements for equipment grounding conductors.

(2) *Ground-fault circuit interrupters.* All 120-volt, single-phase, 15- and 20-ampere receptacle outlets on construction sites, which are not a part of the permanent wiring of the building or structure and which are in use by employees, shall have approved ground-fault circuit interrupters for personnel protection. Receptacles on a two-wire, single-phase portable or vehicle-mounted generator rated not more than 5kW, where the circuit conductors of the generator are insulated from the generator frame and all other grounded surfaces, need not be protected with ground-fault circuit interrupters.

(3) *Assured equipment grounding conductor program.* The employer shall establish and implement an assured equipment grounding conductor program on construction sites covering all cord sets, receptacles which are not a part of the permanent wiring of the building or structure, and equipment connected by cord and plug which are available for use or used by employees. This program shall comply with the following minimum requirements:

(i) A written description of the program, including the specific procedures adopted by the employer, shall be available at the jobsite for inspection and copying by the Assistant Secretary and any affected employee.

(ii) The employer shall designate one or more competent persons (as defined in § 1926.32(f)) to implement the program.

(iii) Each cord set, attachment cap, plug and receptacle of cord sets, and any equipment connected by cord and plug, except cord sets and receptacles which are fixed and not exposed to damage, shall be visually inspected before each day's use for external defects, such as deformed or missing pins or insulation damage, and for indication of possible internal damage. Equipment found damaged or defective may not be used until repaired.

(iv) The following tests shall be performed on all cord sets, receptacles which are not a part of the permanent wiring of the building or structure, and cord- and plug-connected equipment required to be grounded:

(A) All equipment grounding conductors shall be tested for continuity and shall be electrically continuous.

(B) Each receptacle and attachment cap or plug shall be tested for correct attachment of the equipment grounding conductor. The equipment grounding conductor shall be connected to its proper terminal.

(v) All required tests shall be performed:

(A) Before first use;

(B) Before equipment is returned to service following any repairs;

(C) Before equipment is used after any incident which can be reasonably suspected to have caused damage (for example, when a cord set is run over); and

(D) At intervals not to exceed 3 months, except that cord sets and receptacles which are fixed and not exposed to damage shall be tested at intervals not exceeding 6 months.

(vi) The employer may not make available or permit the use by employees of any equipment which has not met the requirements of this paragraph (h)(3) of this section.

(vii) Tests performed as required in this paragraph shall be recorded. This test record shall identify each receptacle, cord set, and cord- and plug-connected equipment that passed the test, and shall indicate the last date it was tested or the interval for which it was tested. This record shall be kept by means of logs, color coding, or other effective means, and shall be maintained until replaced by a more current record. The record shall be made available on the jobsite for inspection by the Assistant Secretary and any affected employee.

Effective date: These amendments of Parts 1910 and 1926 become effective on February 22, 1977.

(Secs. 6(b) and 8(c), Pub. L. 91-596, 84 Stat. 1593, 1599 (29 U.S.C. 655, 657); sec. 107, Pub. L. 91-54, 83 Stat. 96 (40 U.S.C. 333); Secretary of Labor's Order No. 8-76 (41 FR 25059); 29 CFR Part 1911).

Signed at Washington, D.C., this 15th day of December, 1976.

MORTON CORN,
Assistant Secretary of Labor.

[FR Doc.76-37472 Filed 12-17-76;8:45 am]

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